THE FLORA OF THE SANTA ANA CAÑON REGION

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The following report on the flora of the Santa Ana Cañon region has been prepared as a contribution to our knowledge of the botany of a small area in southern California and as a record of the plant communities found there. It was written after a detailed field study of the region had been made, a study extending over a period of about two years while the writer was resident botanist at the Rancho Santa Ana Botanic Garden.* Because of the location of the cañon between the arid interior and the relatively humid coastal region, an interesting variety of species is found assembled together, some of which probably grow together in no other locality. To better understand the climatic and edaphic influences affecting vegetation in the cañon a short account of the geology and climate is given. The determination of most of the plant names occurring in the lists of this report is based on specimens in the herbarium of the writer. "A Manual of the Flowering Plants of California" by W. L. Jepson has been used in determining the names of most of the plants in this report.

LOCATION. The Santa Ana Cañon is situated in southern California in Orange and Riverside counties at an altitude of about 500 ft. It is approximately 12 miles long and ¼ to 1½ miles wide, and extends in nearly an east-west direction. The south-east end of the Puente Hills forms the northern wall of the cañon and the northern end of the Santa Ana Mountains forms the southern wall. The Santa Ana River, which with its tributaries drains the large interior basin extending from the eastern end of the San Gabriel Mountains to the San Gorgonio Pass and Temescal Cañon, flows through the Santa Ana Cañon before reaching the Santa Ana coastal plain west of the Santa Ana Mountains. It is unfortunate that the rugged mountain cañon traversed by the Santa Ana River in the San Bernardino Mountains in the upper reaches of its course is also designated the Santa Ana Cañon. The two cañons are not to be confused for they are entirely unrelated geologically as well as physiologically, and geographically they are separated by the broad valley lands and alluvial slopes of the San Bernardino Valley.

GEOLOGY. Two major faults of southern California occur in the Santa Ana Cañon region and are responsible in part for its

*The Rancho Santa Ana Botanic Garden consists of two hundred acres lying on the summit of the hills, north side of the Santa Ana River Cañon near its mouth. The garden has been recently founded by Mrs. Susanna Bixby Bryant who plans to make it a garden of native Californian plants, at least of all species susceptible of being grown here. An irrigation system has been installed and a large administration building completed. The herbarium contains nearly two thousand mounted specimens. At the same time Mrs. Bryant is building up a valuable botanical library having to do with the flora of western America.—W. L. JEPSON.

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existence: the Whittier fault which extends along the south-west side of the Puente Hills and through the Santa Ana Cañon to the north-east end of the Santa Ana Mountains, and the Chino-Elsinore fault which extends along the east side of the Puente Hills and the Santa Ana Mountains. During the wide-spread orogenic disturbance which occurred near the close of the Tertiary Period of geologic time the Puente Hills and Santa Ana Mountains were uplifted along these two fault lines. This uplift occurred simultaneously with the upbuilding of the San Gabriel, San Bernardino, and San Jacinto ranges and with the last major uplift of the Sierra Nevada Mountains.[1] During this time of uplift the Santa Ana River maintained its course to the west and degraded the rising barrier. Thus the "Santa Ana Cañon is the valley of an antecedant river", a river which held its course during the upbuilding of a mountain range across its path.[2]

The petrography of the region in relation to the location of the Santa Ana Cañon and to the present topographic features of the region is significant. All rocks found in the Puente Hills in the vicinity of the cañon are of sedimentary origin and vary from finely bedded shales to coarse sandstone and conglomerate. Weathering in this section has produced a region of rounded hills with frequent outcrops of resistant strata and occasional rocky bluffs. The mountainous and rugged topography of the northern end of the Santa Ana Mountains at the eastern end of the cañon is in striking contrast to the hills of the northern side. Here the heart of the mountain mass is of hard metamorphic and grantic rocks, resistant to rapid erosion. To the west of the summit ridge sedimentary rocks overlay the igneous rocks and this foothill area resembles in rock types and in physiographic features the hills on the north side of the cañon. It is of interest that the Santa Ana River maintained its course as an antecedant stream at the north end of the granitic core of the Santa Ana Mountains and cut its cañon in rocks relatively less resistant.

Climate. The climate of the Santa Ana Cañon region is that of interior coastal southern California characterized by a hot summer season of drought that is tempered in the cañon by fogs and relatively humid westerly winds, and a cooler winter season of rainfall that is accompanied at intervals by warm and drying easterly winds often of gale force, locally called Santa Anas. No rainfall or temperature data are obtainable for the cañon but such data from Anaheim near the western entrance of the cañon are available. The average annual rainfall at Anaheim is 11.5 inches and the average annual temperature is 64.3°F. The rainfall in the cañon is reported locally to average about 12 inches annually but on the higher slopes of the Santa Ana Mountains it is very much more,

[1] Walter A. English, Geology and Oil Resources of the Puente Hills Region, Southern California, U. S. Geol. Sur. Bull. 768: 48 (1926).

[2] Loc. cit., p. 65.

and is accompanied by some snowfall, generally above 3000 feet. The temperature of the cañon is somewhat higher than that of the coastal plain in the summer, and in the winter it is higher because of the warm "Santa Anas".

The climate of the Santa Ana Cañon region is shown on Russell's map in his recent classification of the climates of California[3] as a uniform warm-humid type with hot, dry summers (the hot summer type of the Mediterranean climate or "Olive Climate") placed between two areas of the hot-dry-steppe type, the one area coastal, the other inland. However the two climates are both well developed and differentiated in the cañon although the area occupied by the latter type is scarcely sufficient to be mapped. Extending from the San Bernardino Valley of the hot-dry-steppe type to the same type on the Santa Ana coastal plain there is a distinct belt characterized by this climatic type on the southern, cañon-side slopes of the Puente Hills. Physiologically this has had a marked effect for on these hills there is no development of chaparral, the brush formation being the Salvia-Artemisia Association[4], a more arid type than the true chaparral. Characteristic of these slopes also are plants of the arid interior valleys and desert which are rare or absent from the chaparral and cañons of the northern Santa Ana Mountains and the central and northern Puente Hills. This effect of exposure is of the same character as that pointed out by Hall[5] and Jepson[6] in connection with irregularities of life zones.

Furthermore the steppe climate in the Santa Ana Cañon marks a transitional stage from the coastal steppe climate to the interior steppe climate, the two climatic regions being locally very distinct in the amount and duration of foggy weather and in the matter of relative humidity and temperature. And as will be shown in the following discussion, the vegetation of the cañon region is characterized to a marked degree as a transition from the coastal flora to the interior flora, reflecting in a vegetative way the climatic transition. In summary: in the region of the Santa Ana Cañon there are two climatic types: one, the hot-dry-steppe type determined by 9.5 to 14 inches of annual rainfall with an average annual temperature of 55°F. or more; and two, the hot-dry-summer type of Mediterranean climate determined by an annual rainfall of over 14 inches with an average annual temperature of 55°F. and with the average temperature for the warmest month above 71°F.

Life Zones and Plant Formations. The flora of the Santa Ana Cañon region is nearly confined to the Upper Sonoran Zone.[7] At

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[3] R. J. Russell, Climates of California, Univ. Calif. Publ. Geogr. 2: (1926).

[4] F. E. Clements, Plant Indicators, Carnegie Inst. Publ. 290: 160 (1920).

[5] H. M. Hall, Botanical Survey of San Jacinto Mountain, Univ. Calif. Publ. Bot. 1: 34 (1902).

[6] W. L. Jepson, A Manual of the Flowering Plants of California, 9 (1925).

[7] C. H. Merriam, Life Zones and Crop Zones in the United States, Bull. U. S. Biol. Survey (1898).

the northern end of the Santa Ana Mountains the lower Transition Zone is suggested in the deep cañons where Pseudotsuga macrocarpa, Umbellularia californica, and Acer macrophyllum are found and further south on the higher peaks of the range where an open growth of Pinus coulteri occurs in the chaparral and Pseudotsuga macrocarpa is found on slopes and in the cañons. The grassland covering the clay flats and more gently rolling hills of the western slope of the Santa Ana Mountains and of the Puente Hills probably represents Lower Sonoran. However the grassland areas are limited in extent and on nearly all the steeper slopes the woody plants of the lower part of the Upper Sonoran are becoming established—Eriogonum fasciculatum var. foliolosum, Ericameria palmeri, Gutierrezia sarothrae, and Artemisia californica. All the rest of the region lies within the Upper Sonoran Zone. Due to the variations of soil, moisture and topography in this zone several marked and easily defined plant communities have developed.

To understand better these various plant communities and their interrelationships and to appreciate more fully the types of habitat in which plants of the region occur, it has seemed best to describe the plant communities after the manner of field ecologists taking into consideration such topographic, edaphic, and climatic features that appear important. For these purposes the classification of plant communities given by Clements in his work "Plant Indicators"[8] is used here as a basis for discussion. According to this classification the following plant associations are found in the region of the Santa Ana Cañon:

A. Stipa-Bouteloua Formation or Grassland Climax.
   1. Agropyron-Stipa Association or Bunch-grass Prairie (weak development).
B. Atriplex-Artemisia Formation or Sagebrush Climax.
   1. Salvia-Artemisia Association or Coastal Sagebrush.
C. Quercus-Ceanothus Formation or Chaparral Climax.
   1. Adenostoma-Ceanothus Association or Coastal Chaparral.
D. Pinus-Pseudotsuga Formation or Montane Forest Climax.
   1. Pinus Association or Sierra Montane Forest (very weak development).

Since the flora of the ponds, marshes, and flats of the Santa Ana River bottom is not included in the above divisions, it is described as a separate formation.

Grassland Formation. As stated above the grassland as a plant formation is of very limited extent and is confined to flats and gently sloping hillsides that have a deep surface layer of clayey soil. The grasses of these areas are largely introduced annual species including Bromus rubens, Lamarckia aurea, Hordeum murinum, and Avena barbata, the characteristic perennial grasses being Stipa lepida and Stipa pulchra, both natives. Numerous species of herbaceous plants,

[8] F. E. Clements, Plant Indicators, Carnegie Inst. Publ. no. 290 (1920).

annual and perennial, other than grasses are characteristic of the grassy areas and form definite societies at different seasons. Among the spring flowers are Calochortus catalinae, Ranunculus californicus, Lepidium nitidum, Lupinus succulentus, Amsinckia douglasiana, Orthocarpus purpurascens, Uropappus lindleyi, and Layia platyglossa. At this time too in favorable years large areas of hillside are covered with Brassica nigra. In May and June a late vernal society develops that includes such types as Lotus salsuginosus var. brevivexillus, Lotus hamatus, Godetia quadrivulnera, Centaurium venustum, Linanthus pharnaceoides, Mimulus brevipes, and Hemizonia fasciculata, and during the summer Cucurbita foetidissima, Asclepias eriocarpa, and Grindelia camporum var. are characteristic perennial herbs. In late summer and fall a society made up mainly of perennial suffrutescent plants develops and while it reaches a higher development on sandy slopes and rocky hillsides numerous individuals are found in the grassland especially where it borders the sagebrush formation. The commonest perennial species of this group are Eriogonum elongatum, Gutierrezia sarothrae, Ericameria palmeri, Isocoma veneta var. vernonioides, Corethrogyne filaginifolia var. rigida, and Artemisia californica, and the tall annuals or biennials, Stephanomeria virgata and Malacothrix altissima are conspicuous on flats and road-cuts in clay soil.

Sagebrush Formation. The sagebrush formation has a high development in the hills on either side of the Santa Ana Cañon where it occurs on sandy washes and eroding surfaces and on rocky slopes and hillsides where the residual soil is shallow or lacking. In the southern Puente Hills it is the only well developed brush formation while in the Santa Ana Mountains it is either weakly developed along the lower edges of the chaparral, or in favorable locations is well developed as a broad belt between the grassland of the lower foothills and the chaparral. This sagebrush formation is the "foothill formation" according to McKenney[9] as contrasted with his "mountain formation" or chaparral. According to Abrams[10] it is the lowest belt of the chaparral, a belt intermediate between the Upper and Lower Sonoran Zones. Clements[11] treats the whole coastal sagebrush as a single climax formation, sometimes represented in certain areas by a pure society composed of either Eriogonum fasciculatum var, foliolosum, Salvia mellifera, Salvia leucophylla, Salvia apiana, or Artemisia californica. Cooper[12] indicates that there are probably two aspects of the coastal sagebrush climax of Clements—one, "undoubtedly climax in certain portions of the interior valleys" of south-

[9] R. E. B. McKenney, Notes on Plant Distribution in Southern California, Beih. zum Bot. Cent. 10: 168 (1901).

[10] LeRoy Abrams, A Phytogeographic and Taxonomic Study of the Southern Californian Trees and Shrubs, Bull. N. Y. Bot. Gard. 6: 316 (1910).

[11] F. E. Clements, Plant Indicators, p. 160.

[12] W. S. Cooper, The Broad Sclerophyll of California, Carnegie Inst. Publ. no. 319: 82 (1922).

ern California, and two, successional, leading to a true chaparral climax. Under the successional sagebrush, Cooper describes the *primary* sagebrush succession[13] as having marked and characteristic development on alluvial fans and erosional slopes, and the *secondary* sagebrush succession[14] as having definite development within a chaparral area following fire. In the Santa Ana Cañon region only the primary sagebrush succession was observed.

Cooper's idea of the dual nature of the Atriplex-Artemisia Association of Clements agrees with observations made in the Santa Ana Cañon region. There extensive areas of matured physiographic character are uniformly planted with Salvia mellifera, Salvia leucophylla, and Artemisia californica and such plantings have the characteristics of a true climax brush formation and in the same region Eriogonum fasciculatum var. foliolosum, Salvia mellifera, Salvia apiana, and Artemisia californica inhabit in irregular plantings the rocky slopes of recently eroded sedimentary deposits and the surfaces of recent alluvial washes, representing the primary successional sagebrush spoken of by Cooper. The two types of sagebrush vegetation are very distinctive in appearance and when studied in connection with the physiographic ages of the two habitats where they occur, the two types can scarcely be confused.

Cooper's theory that the primary sagebrush succession leads to a chaparral climax is substantiated by the flora found on the bluffs of the Puente Hills near the eastern end of the Santa Ana Cañon. Here plants characteristic of the primary successional sagebrush flora grow with Adenostoma fasciculatum and other species usually associated with the chaparral. This group of plants constitutes the nearest approach to true chaparral in the southern Puente Hills and is of particular interest when considered in relation to the chaparral which has such a high development on the slopes of Sierra Peak just across the cañon about one-fourth mile distant. In this transitional area of sagebrush to chaparral the following plants are growing: Eriogonum fasciculatum var. foliolosum, Adenostoma fasciculatum, Photinia arbutifolia, Lotus scoparius, Stillingia linearifolia, Rhus laurina, Rhus integrifolia, Rhus ovata, Rhamnus crocea var. ilicifolia, Sphaeralcea fasciculata var. laxiflora, Helianthemum scoparium var. vulgare, Leptodactylon californicum, Salvia mellifera, Gutierrezia sarothrae, and Encelia californica.

The plants of the sagebrush formation can be easily divided between two communities—the one inhabiting the exposed, hot southern slopes, the other inhabiting the shaded northern slopes and cañon-sides. The plants are generally not confined to one habitat but are often better developed in one than in the other, and in the following lists the plants are named as characteristic of that habitat in which they are more numerous and more fully developed. Characteristic shrubby or suffrutescent plants of the southern slopes are Eriogonum

[13] Loc. cit., p. 82.

[14] Loc. cit., p. 86

fasciculatum var. foliolosum, Astragalus leucopsis, Rhus laurina, Sphaeralcea fasciculata var. laxiflora, Opuntia occidentalis, Opuntia vaseyi, form related to Opuntia parryi, Salvia mellifera, Salvia leucophylla, Salvia apiana, Castilleja foliolosa, Galium angustifolium, Gnaphalium beneolens, Artemisia californica, and a distinctive fall flora consisting of Eriogonum elongatum, Brickellia californica, Gutierrezia sarothrae, Ericameria palmeri, Ericameria pinifolia, Isocoma veneta var. vernonioides, Hazardia squarrosa, Chrysopsis villosa var. fastigiata, Corethrogyne filaginifolia var. rigida, Artemisia dracunculus. Nicotiana glauca is conspicuous on slopes where surface soil has been disturbed. Among the annual and perennial herbs of these southern slopes are Selaginella bigelovii, Melica imperfecta, Muhlenbergia microsperma, Aristida bromioides, Stipa coronata, Andropogon saccharoides, Sitanion jubatum, Brodiaea capitata, Calochortus splendens, Calochortus weedii var., Chorizanthe staticoides, Eriogonum gracile, Mirabilis laevis, Cotyledon laxa, Lupinus sparsiflorus, Oxalis wrightii, Euphorbia polycarpa, Eulobus californicus, Hugelia virgata, Gilia multicaulis, Emmenanthe penduliflora, Salvia columbariae, Cryptanthe flaccida, Plantago erecta, Chaenactis glabriuscula, Chaenactis artemisiaefolia, Baeria aristata, Senecio californicus. On the northern slopes and cañon-sides the commonest shrubs and woody-based plants are Quercus dumosa var. elegantula, Ribes malvaefolia, Ribes speciosum, Photinia arbutifolia, Polygala cornuta var. fishiae, Rhus diversiloba. Rhus integrifolia, Rhus ovata, Rhamnus crocea var. ilicifolia, Solanum douglasii, Solanum xantii, Pentstemon cordifolius, Pentstemon antirrhinoides, Diplacus longiflorus, Lonicera subspicata, Eriophyllum confertiflorum. Herbs found among these shrubs on shaded cañon-sides are Pterostegia drymarioides, Montia perfoliata, Paeonia brownii, Thysanocarpus laciniatus, Godetia bottae, Osmorrhiza brachypoda, Bowlesia lobata, Nemophila aurita, Phacelia hispida, Galium nuttallii, Rafinesquia californica. Trees frequently found in the cañons of the sagebrush formation are Quercus agrifolia, Juglans californica, and Platanus racemosa. On sandy washes of the larger cañons Lepidospartum squamatum is a characteristic shrub while in more stable situations of the drier cañon bottoms Yucca whipplei, Nolina parryi, Delphinium cardinale, Romneya coulteri, Fraxinus dipetala, Philibertia heterophylla, Senecio douglasii, and Tetradymia comosa grow in open formation with mingled trees and shrubs from the sagebrush and the chaparral.

Chaparral Formation. The coastal chaparral[15] is well developed on the higher and rockier slopes of the northern end of the Santa Ana Mountains in the vicinity of the Santa Ana Cañon and over most of the slopes of Sierra Peak it forms a dense and uniform covering. The formation is practically absent from the Puente Hills on the northern side of the cañon and almost without doubt it is un-

[15] F. E. Clements, loc. cit., p. 190.

favorable climatic factors that retard or inhibit the development of chaparral there. "Of direct and fundamental importance is soil moisture"[16] and it is probable that sufficient moisture is not present in the southern slopes of the Puente Hills during the winter growing period to allow chaparral species to thrive. In the preliminary discussion on the climate of the Santa Ana Cañon region it was pointed out that there is a hotter, drier type of climate in the southern Puente Hills than in the northern Santa Ana Mountains and in relation to the distribution of chaparral in this region these climatic variations appear to have fundamental significance.

In the northern Santa Ana Mountains there is a distinct mingling of plants of the sagebrush formation and the chaparral along the lower edges of the chaparral. The result is a mixed shrub formation in which neither the species of the chaparral nor of the sagebrush are dominant. At one station in Claymine Cañon on the lower slopes of Sierra Peak at the lower edge of the chaparral the following species grow together in close brush formation on a moderately sloping rocky hillside: Eriogonum fasciculatum var. foliolosum, Adenostoma fasciculatum, Photinia arbutifolia, Lotus scoparius, Rhus laurina, Rhus integrifolia, Rhamnus crocea var. ilicifolia, Ceanothus macrocarpus, Leptodactylon californicum, Salvia mellifera, Salvia apiana, Trichostema lanatum, Pentstemon antirrhinoides, Diplacus longiflorus, Galium angustifolium, Eriophyllum confertiflorum, and Artemisia californica. Nolina parryi, Yucca whipplei, Romneya coulteri, Prunus ilicifolia, Rhus ovata, and Helianthus gracilentus are also commonly present in such mixed brush formations. This mixed chaparral and sagebrush is found along the lower edges of the chaparral where it sometimes forms a broad belt and it is the characteristic type of vegetation in deep narrow cañons that extend far up into the chaparral of the higher slopes.

The most abundant members of the true chaparral are Adenostoma fasciculatum, Ceanothus tomentosus var. olivaceus, Ceanothus macrocarpus, Ceanothus crassifolius, Arctostaphylos glauca, Arctostaphylos glandulosa. As has been pointed out by Abrams[17] Adenostoma fasciculatum dominates the lower part of the chaparral and the species of Ceanothus and Arctostaphylos prevail at higher altitudes. Other plants more or less numerous in the chaparral of the northern Santa Ana Mountains are Yucca whipplei, Nolina parryi, Dendromecon rigida, Cercocarpus betuloides, Pickeringia montana, Rhamnus californica, Leptodactylon californicum, Eriodictyon crassifolium, Trichostema lanatum, Sphacele calycina var. glabella. Cupressus forbesii, here at the northern limit of its range, forms interesting colonies in the chaparral generally as shrubby densely branched trees less than 30 feet high.

River-bottom Flora. The narrow floor of the Santa Ana Cañon

[16] W. S. Cooper, loc. cit., p. 63.
[17] L. Abrams, loc. cit., p. 316

is a nearly level area bounded by the cañon walls. In parts the whole of the cañon floor is occupied by the sandy flood-plain and broad bottom lands of the Santa Ana River, in other parts above the river-bottom there are broad arable fields that slope down from the cañon walls. Although during the irrigating season nearly all the water is taken from the river near the eastern end of the cañon, water is found in the river-bed some distance below the canal intake and water is found at all times in numerous ponds and marshes of the river-bottom. All types of habitat from truly aquatic to paludose and moist riparian are to be found, accommodating a varied flora. At a few points alluvial fans extend into the cañon from the north or south and here and there in the broad river-bottom are bar-like ridges or "islands" five to ten feet above the river level. These fans and "islands" due to their height above the river level and their sandy rocky character are much drier than any other part of the river-bottom and are related floristicly to the arid hills covered by plants of the sagebrush formation. On the fans and "islands" of the river-bottom grow some of the most interesting plants of the cañon, plants that are native of the interior valleys and that are brought into the cañon at times of flood.

The ponds and marshes of the river-bottom are frequent in the middle and upper parts of the cañon but become rarer to the west where, during the summer, the river is marked only by the sandy expanse of the broad dry bed. Submerged aquatics of the ponds include Potamogeton crispus, Zannichellia palustris, Lemna trisulca, and Myriophyllum spicatum and the floating flora is composed of such widely distributed species as Azolla filiculoides, Lemna minor, and Wolfiella lingulata. In the shallow water of the marshes are found Typha angustifolia, Cyperus melanostachyus, Eleocharis rostellata, Scirpus validus, Scirpus americanus, Polygonum hydropiperoides, Radicula nasturtium-aquaticum, Jussiaea californica, Oenanthe sarmentosa, Samolus floribundus, Lycopus americanus, Bidens levis, and Helenium puberulum. A large number of sedges and rushes are found on the moist flats of the river-bottom, among which are: Cyperus laevigatus, Cyperus esculentus, Eleocharis capitata, Eleocharis acicularis, Eleocharis montana, Scirpus cernuus, Carex praegracilis, Juncus balticus, Juncus bufonius, Juncus torreyi, Juncus rugulosus, and Juncus xiphioides. Other plants growing on the moist flats with the sedges and rushes are: Equisetum funstonii, Distichlis spicata, Sporobolus asperifolius, Sporobolus airoides, Cynodon dactylon, Paspalum distichum, Cenchrus pauciflorus, Anemopsis californica, Ranunculus cymbalaria, Psoralea orbicularis, Psoralea macrostachya, Lythrum californicum, Epilobium californicum, Hydrocotyle ranunculoides, Hydrocotyle umbellata, Hydrocotyle verticillata, Eustoma silenifolium, Lippia lanceolata, Petunia parviflora, Mimulus cardinalis, Plantago hirtella, Solidago occidentalis, Aster exilis, Baccharis emoryi, Baccharis viminea, Pluchea camphorata, Artemisia vulgaris var. heterophylla. On the sandy flats and "islands" of the river-bottom grow four species of willow, Salix laevigata,

Salix nigra var. vallicola, Salix argophylla, and Salix lasiolepis, besides Populus fremontii, Populus trichocarpa, Alnus rhombifolia, and Platanus racemosa.

The "islands" of the river-bottom have already been described, and the fact that the character of the vegetation is that of the sagebrush formation of the hillsides has been mentioned. Many of the plants found on the "islands" are of the same species as those found in the sagebrush but many are not and appear to be plants brought into the cañon during floods. Eriogonum thurberi, Amorpha fruticosa, Stillingia linearifolia, Hugelia densifolia var. sanctorum, Eriodictyon trichocalyx, Eriodictyon crassifolium, Pluchea sericea, Artemisia tridentata, and Artemisia dracunculus (a form distinctly different from that of the hillsides) appear to be of this type, most of these species being found in the interior valleys and mountains. Even several specimens of Cupressus forbesii are to be found in the river-bottom. Other plants of the drier parts of the river-bottom are Clematis ligusticifolia, Rosa californica, Croton californicus, Vitis girdiana, and Senecio douglasii, and such annual species as Loeflingia squarrosa, Lepidium lasiocarpum, Tillaea erecta of the spring and Heterotheca grandiflora, Ambrosia psilostachya, and Franseria acanthicarpa of the fall.

The Santa Ana Cañon Flora. In his treatment of the Upper Sonoran Zone in southern California Abrams recognizes three sub-districts[18]—Littoral, the seashore belt; Coastal, the fog belt; and Interior, the chaparral belt. The flora of the Santa Ana Cañon region marks the transition from the flora of the Coastal Sub-district to that of the Interior Sub-district and growing together in the cañon are plants representative of either the one or the other of the sub-districts. Out of twenty-two species which Abrams considers typical of the Coastal Sub-district eight are found in the Santa Ana Cañon region, out of twelve species listed for the Interior Sub-district four are represented or common in the cañon region, and out of fourteen species of the "Lower Sonoran of the interior valleys"[19] four species occur in the Santa Ana Cañon. These species are: Juglans californica, Ribes speciosum, Lupinus longifolius, Polygala cornuta var. fishiae, Rhus laurina, Ceanothus macrocarpus, Trichostema lanatum, Salvia leucophylla from the Coastal Sub-district; Pseudotsuga macrocarpa, Pickeringia montana, Ceanothus crassifolius, and Pentstemon antirrhinoides from the Interior Sub-district; Ericameria pinifolia, Bebbia juncea, Lepidospartum squamatum, and Tetradymia comosa from the interior Lower Sonoran valleys. Salix nigra var. vallicola, Salix argophylla, Atriplex canescens, Baccharis emoryi, Pluchea sericea, and Lepidospartum squamatum, all of which are well represented in the cañon, are given by Abrams as characteristic trees and shrubs of the Lower Sonoran Zone of the Mojave Desert. Other plants

[18] L. Abrams, loc. cit., p. 314.

[19] Loc. cit., p. 319.

found in the cañon that are characteristic of these several areas named by Abrams are: Dicentra ochroleuca, Hasseanthus variegatum var. elongatum, Rhus integrifolia, Nemophila aurita, Ellisia chrysanthemifolia, and Encelia californica from the coast; Jepsonia parryi, Rhus ovata, Hugelia densifolia var. sanctorum, Porophyllum gracile, and Artemisia tridentata from the interior. Of these latter, Dicentra ochroleuca which is found near the top of Sierra Peak in the chaparral and Porophyllum gracile which is locally common on a rocky hog-back ridge in the sagebrush have not been reported from the Santa Ana Cañon region and represent extensions of range—the first from Santa Monica Mountains southward, the second from the Riverside district westward.

JOHANN FRIEDERICH ESCHSCHOLTZ

Willis Linn Jepson

On Oct. 2, 1815, the exploring ship Rurik entered San Francisco Bay. It had been fitted out by the Russian chancellor, Count Rumiantzof, to undertake a round the world voyage of discovery under the command of Lieutenant Otto von Kotzebue of the Russian Imperial Navy. Two naturalists accompanied the voyage, Adelbert von Chamisso and Dr. J. F. Eschscholtz, the latter being the surgeon of the expedition. These two botanized on the San Francisco peninsula during the month of October, after which the Rurik sailed for the Sandwich Islands on November 1.

Among the new plants collected at San Francisco was a poppy-like species which Chamisso, after his return home, dedicated to his companion as a new genus, Eschscholtzia, and thus made well-known to all future Californians the name of the surgeon of the Rurik. Probably the first paper devoted exclusively, save for a few post-scriptal notes, to Californian plants and carrying California in its title, was written by Eschscholtz. This paper, "Descriptiones Plantarum Novae Californiae," was published in the Mémoires de l'Académie Impériale des Sciences de St. Pétersbourg in 1823. For the first time we have here named and described various very common Californian plants: Abronia latifolia, Navarretia (Hoitzia) squarrosa, Polemonium capitatum, Solanum umbelliferum, Ceanothus thrysiflorus, Rhamnus californica and Lupinus chamissonis.

When Kotzebue undertook his second voyage of exploration Dr. Eschscholtz again went out with him. After this Eschscholtz became professor of anatomy in the University of Dorpat. His writings are of importance but they lie mainly in the field of zoology. Born at Dorpat in November, 1753, he died there in May, 1831.

[Otto von Kotzebue, A voyage of discovery into the South Sea and Bering's Straits, 1:275-290; 3: 38-51 (London, 1821). Adelbert von Chamisso, Werke, ed. 3, 1: 141-155 (1852); Entdeckungsreise um die welt, 103-118 (Munich, 1925).]